

NATIONAL RESEARCH COUNCIL

BOARD ON RADIOACTIVE WASTE MANAGEMENT

WATER SCIENCE AND TECHNOLOGY BOARD

2101 Constitution Avenue Washington, D.C. 20418

Executive Office

December 10, 1998

Mr. Mark Gilbertson
Office of Science and Risk Policy
U.S. Department of Energy
Washington, D.C. 20585

Dear Mr. Gilbertson:

At the request of the [Department of Energy's \(DOE's\) Office of Science and Risk Policy](#), the [National Research Council](#) empaneled a committee¹ to assist the Department in developing a long-range science plan for subsurface contamination research sponsored by the [Environmental Management Science Program \(EMSP\)](#).² The committee was asked by DOE to develop an interim report---which is provided in this letter---on the technical content of the EMSP proposal call for fiscal year 1999 (FY99),³ which DOE intends to focus on subsurface contamination problems. This interim report reflects a consensus of the committee. It has been reviewed in accordance with the procedures of the National Research Council.⁴

The information used to develop this interim report was obtained from several sources. The committee reviewed previous National Research Council reports on the EMSP.⁵ The committee also held two information-gathering meetings to familiarize itself with subsurface contamination problems at the five major DOE complex sites: [Hanford, Idaho](#), [Oak Ridge, Rocky Flats](#), and [Savannah River](#). The first meeting, which was held on September 9-10, 1998 in Washington, D.C., provided the committee with an overview of the contamination problems at all five of these sites. The second meeting was held on November 10-12, 1998, in Augusta, Georgia and focused on subsurface contamination problems at the Oak Ridge and Savannah River sites. A third meeting is planned for December 15-17, 1998 to obtain additional information on contamination problems at the Hanford, Idaho, and Nevada Test Sites.

The committee also reviewed the portfolio of subsurface contamination-related research projects supported by the EMSP since its inception in 1996.⁶ This information included project titles, principal investigator names and affiliations, and project abstracts. The purpose of this

¹Committee on Subsurface Contamination at DOE Complex Sites: Research Needs and Opportunities. The roster for this committee is given in [Attachment A](#).

²The committee's statement of task is given in [Attachment B](#).

³DOE intends to publish the proposal call in the Federal Register in January 1999.

⁴The list of reviewers is given in [Attachment C](#).

⁵Three reports were written by the Committee on Building an Environmental Management Science Program in 1996-97. All three reports are reproduced in the report entitled [Building an Effective Environmental Management Science Program: Final Assessment](#) (National Research Council, 1997).

⁶Information for this assessment was provided in two Department of Energy reports: U.S. Department of Energy. 1998. [Report to Congress on the U.S. Department of Energy's Environmental Management Science Program](#). DOE/EM-0357. Washington, D.C.: DOE Office of Environmental Management; and U.S. Department of Energy. 1998. [Environmental Management Science Program Workshop](#). CONF-980736. Washington, D.C.: DOE Office of Environmental Management.

assessment was to determine the range of research problems being addressed by the program and also to begin the process of identifying potential research gaps. This assessment was conducted by grouping the projects into the following five subsurface contamination problem areas defined by DOE's Subsurface Contaminants Focus Area (SCFA):⁷

- Locate and quantify---Detect and characterize subsurface contamination.
- Contain and stabilize---Eliminate or reduce significantly the migration of contaminants in the subsurface.
- Treat or destroy in situ---Remediate subsurface contamination in place.
- Remove hotspots---Selectively remove highly contaminated zones from the subsurface.
- Validate performance---Confirm the effectiveness of remediation processes or strategies.

These problem areas are being used by the SCFA to organize its subsurface contamination technology development activities. The committee adopted this scheme for organizing its assessment of the EMSP portfolio mainly for convenience, but also because this scheme has the potential to provide a direct linkage between research in the EMSP and technology development in the SCFA. The committee may decide to modify or abandon this scheme as it continues its deliberations.

Given the limited information gathering and deliberations to date, the committee can offer only general advice to DOE on the technical content of the FY99 proposal call. The committee hopes that the following advice will be helpful to the Department:

1. *Focus on basic research.* As noted by previous National Research Council reports (see footnote 5), the purpose of the EMSP is to foster basic research⁸ that will contribute to successful completion of DOE's mission to cleanup the environmental contamination across the DOE complex. The committee recommends that DOE articulate clearly the program's focus on basic research---not site-specific remediation problems---in the proposal call.

2. *Focus on subsurface contamination research.* Although the focus of the EMSP is on basic research, as noted above, the objective of this research program is to generate new knowledge to support DOE's mission to remediate its contaminated sites. Some of the Department's most significant contamination problems involve soil and groundwater that contain DNAPLs,⁹ metals, and radionuclides. The Department's ability to identify and quantify contaminant sources, predict and monitor contaminant fate, and carry out appropriate

⁷The Subsurface Contaminants Focus Area is part of the Office of Science and Technology within DOE's Office of Environmental Management, the latter of which has the overall responsibility for cleanup of the weapons complex. Mr. Tom Hicks of the Subsurface Contaminants Focus Area provided the five problem areas in a presentation at the committee's first meeting.

⁸Research that "creates new knowledge; is generic, non-appropriable, and openly available; is often done with no specific application in mind; requires a long-term commitment." (*Allocating Federal Funds for Basic Research*, National Research Council, 1995, p. 6).

⁹DNAPLs, or dense non-aqueous phase liquids, are chlorinated organic solvents such as perchloroethylene and trichloroethylene.

remediation remains elusive at many sites across the DOE complex. The Department has published several reports that highlight subsurface contamination as a significant long-term problem.¹⁰ Moreover, the EMSP portfolio is well represented by research projects focused on subsurface contamination problems. Thus, DOE's plan to focus the proposal call on subsurface contamination problems seems prudent to the committee in light of the scope of these problems across the complex.

Restricting the proposal call to subsurface contamination problems also seems prudent to the committee in view of the limited funding available to the EMSP. About \$10 million will be available to the program in FY99, which will be sufficient to support between 20 and 30 three-year projects.¹¹ By restricting the proposal call, the Department may be able to approach a "critical mass" of projects in its subsurface contamination research portfolio and thereby make a significant contribution to solving difficult and costly problems at its sites.

3. *Complex-wide focus.* It is apparent to the committee that DOE still faces significant subsurface contamination problems at all five of its major sites. Some problems, like DNAPL and tritium contamination in groundwater, are common to all live sites, whereas other problems, such as mercury contamination in soil, appear to be less common across the complex. Moreover, all five sites have different geological, hydrological, and climatic conditions and, thus, are in some senses unique. If the EMSP is to make a significant long-term contribution to the Department's mission to cleanup *all* of its sites, the proposal call should encourage the submission of research ideas that address significant subsurface contamination problems across the complex. That is, the proposal call should encourage the submission of proposals that tackle significant science problems that are relevant to any DOE site.

A proposal call with a complex-wide focus would have at least one practical benefit for the EMSP---namely, it likely would increase the quality of the proposal pool. A complex-wide call likely would generate a better selection of proposals from researchers across the nation. The Department could then use its merit and relevance review processes to select for funding those projects that are likely to have highly significant impacts on both science and the cleanup mission as a whole. A more restricted proposal call likely would attract only proposals from researchers who happened to be acquainted with problems at the sites covered in the call. A proposal call with a complex-wide focus would increase competition among research ideas and thereby increase the overall quality of the EMSP research portfolio.

Although the committee recommends a complex-wide focus for the proposal call, it also believes that researchers should be encouraged to demonstrate a linkage between their research projects and significant contamination problems at DOE sites. Researchers could establish this linkage in a variety of ways---for example, by elucidating the scientific problems to

¹⁰See, for example, U.S. Department of Energy, 1997. *Linking Legacies: Connecting the Cold War Nuclear Weapons Production Processes to Their Environmental Consequences*. DOE/EM-0319. Washington, D.C.: DOE Office of Environmental Management; and U.S. Department of Energy. 1998. *Accelerating Cleanup: Paths to Closure*. DOE/EM-0362. Washington, D.C.: DOE Office of Environmental Management.

¹¹Information received from Mark Gilbertson, Director of the Office of Science and Risk Policy, at the committee's second meeting.

be addressed by the proposed research and explaining how the solution of the problems could improve remediation capabilities. Of course, given the nature of basic research, there will not always be a clear pathway between research results and application to site remediation. Nevertheless, the committee believes that this linkage exercise will help researchers focus their proposals on those key scientific problems that have significant implications for site remediation and, moreover, that the linkage information provided in the proposals will help the Department assess project relevance.

4. *Science problems in the proposal call.* Although the committee concurs with DOE's plan to focus the proposal call on subsurface contamination problems, as noted previously, the committee is not yet ready to make specific recommendations on a science plan for subsurface contamination research---that plan will be the subject of the committee's final report. Therefore, the committee believes that the call should be written to encourage the submission of new and innovative basic research ideas that address science problems relevant to all five of the subsurface contamination problem areas described above.

In its preliminary assessment of the EMSP portfolio, the committee has observed that there are relatively few basic research projects in the *validate performance* and possibly the *remove hotspots* problem areas, although the committee's assessment of the latter category is continuing. In the context of the EMSP, *validate performance* concerns the ability to confirm the performance or behavior of a physical, chemical, or biological process or a technology at a contaminated site. Basic science can contribute to performance validation through the investigation and development of new or improved tools and methodologies for confirming behavior or performance in the field. There are a number of underlying theoretical and experimental issues of interest---for example, understanding the pre-remediation conditions at a contaminated site and the fundamental hydrogeological, chemical, and biological controls on site or contaminant behavior, how these change during site remediation, and which tests or measurements are sensitive to the behaviors of concern.

The inability to confirm such behavior or performance at a contaminated site is one of the primary reasons for the Department's difficulty in prescribing appropriate and cost-effective remediation and monitoring strategies.¹² Moreover, once a remediation action is underway, the Department often lacks methods to measure and confirm the efficacy of the approach. Deployment of new remediation technologies may depend to a great extent on the Department's ability to validate their effectiveness---and provide evidence of remediation efficacy to regulators and other stakeholders.

The committee views the basic science issues underlying the *validate performance* problem area as a research opportunity for the EMSP. This problem area is under-represented in the current EMSP portfolio, and new knowledge obtained through the program could lead to significant improvements in remediation capabilities.

¹²The idea that lack of process validation can limit technology application also is discussed in the National Research Council report entitled *Innovations in Ground Water and Soil Cleanup* (National Research Council, 1997).

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Although the committee recommends that the call focus on new and innovative research proposals on the entire spectrum of subsurface contamination problems, the committee suggests that the call also indicate DOE's receptiveness to the submission of new research ideas that address the basic science aspects of performance validation.

Sincerely,

Jane C.S. Long, Chair
James K. Mitchell, Vice-Chair

[Attachment A: Roster of Committee Members](#)
[Attachment B: Statement of Task](#)
[Attachment C: List of Reviewers](#)

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Attachment A

ATTACHMENT A COMMITTEE ROSTER

COMMITTEE ON SUBSURFACE CONTAMINATION AT DOE COMPLEX SITES: RESEARCH NEEDS AND OPPORTUNITIES

JANE C.S. LONG, CHAIR, Mackay School of Mines, University of Nevada, Reno
JAMES K. MITCHELL, VICE CHAIR, Virginia Polytechnic Institute and State University,
Blacksburg
RANDALL J. CHARBENEAU, University of Texas, Austin
JEFFREY J. DANIELS, The Ohio State University, Columbus
JACK N. FISCHER, Hydrologic Consultant, Oakton, Virginia
TISSA H. ILLANGASEKARE, Colorado School of Mines, Golden
AARON L. MILLS, University of Virginia, Charlottesville
DONALD T. REED, Argonne National Laboratory, Illinois
JEROME SACKS, National Institute for Statistical Sciences, Research Triangle Park, North
Carolina
BRIDGET R. SCANLON, Bureau of Economic Geology, University of Texas, Austin
LEON T. SILVER, California Institute of Technology, Pasadena
CLAIRE WELTY, Drexel University, Philadelphia, Pennsylvania

Staff

KEVIN D. CROWLEY, Study Director and Director, Board on Radioactive Waste Management
STEPHEN D. PARKER, Director, Water Science and Technology Board
SUSAN B. MOCKLER, Research Associate, Board on Radioactive Waste Management
PATRICIA A. JONES, Senior Project Assistant, Board on Radioactive Waste Management

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Attachment B

ATTACHMENT B STATEMENT OF TASK

COMMITTEE ON SUBSURFACE CONTAMINATION AT DOE COMPLEX SITES: RESEARCH NEEDS AND OPPORTUNITIES

The objective of this study is to develop a science plan for subsurface contamination research sponsored by DOE's EM Science Program. This science plan will describe the significant subsurface contamination problems at DOE sites that cannot be addressed with current technologies, identify the knowledge gaps relevant to these problems, and develop a research plan to fill these gaps. This plan will take account of research being sponsored by other federal and state agencies and will identify those areas of research where the EM Science Program can make significant contributions to addressing DOE's problems and adding to scientific knowledge generally.

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Attachment C

ATTACHMENT C LIST OF REVIEWERS

This letter report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC'S Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report:

John F. Ahearne, Sigma Xi, The Scientific Research Society and Duke University,
Research Triangle Park, North Carolina
Richelle Allen-King, Washington State University, Pullman
George M. Hornberger, University of Virginia, Charlottesville
Richard G. Luthy, Carnegie Mellon University, Pittsburgh, Pennsylvania
Norine E. Noonan, U.S. Environmental Protection Agency, Washington, D.C.

While the individuals listed above have provided constructive comments and suggestions, it must be emphasized that responsibility for the final content of this report rests entirely with the authoring committee and the institution.